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Computer Assisted Instruction In Schools

Summary

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Alberta
EDUCATION

COMPUTER ASSISTED INSTRUCTION IN SCHOOLS
ACHIEVEMENTS, PRESENT DEVELOPMENTS
AND
PROJECTIONS FOR THE FUTURE

A Report Presented to Alberta Education

by

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EXECUTIVE SUMMARY

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June 1980

In the midst of a computer revolution which is rapidly changing many aspects of people's daily lives it is not easy to foresee the effects on our system of education. However, it can be predicted that the present changes in the storage, processing and dissemination of information will have effects quite as great as those brought about by the introduction of printing, and that they will occur at a much faster rate.

The present organizational structure of education was made possible by the use of printed texts, which are inexpensive when compared to handwritten parchments. The question is, what will be the effects upon education of the present computer revolution?

This study is concerned with one specific aspect of that revolution, namely, computer assisted instruction (CAI). When learning by means of CAI, a student uses a terminal to interact with a teaching program prestored in the computer. The program may provide drill and practice, offer tutorial instruction, or present a simulation. The learning material may be reading or language skills, mathematics or number skills, a foreign language, science, automotive maintenance, nutrition, or any of a wide range of subject matters. The learner may range from a kindergarten child to a post-graduate student. The present concern, however, is with students of school age, and with the curricula that they are expected to learn.

Computer assisted instruction has been used in several large scale projects, some of which began in the early 1960's. A detailed review was made of the larger and more important CAI projects in the United States, Europe and Canada. An account is given of the Stanford University project and its drill and practice programs. These are now distributed commercially and are used more extensively than any other form of CAI at school level, principally for mathematics, reading, and language. They provide the courseware for large-scale use of CAI in the schools of Chicago. The PLATO project at the University of Illinois is characterized by the size of the computer used and the large number of terminals supported, also by the technical ingenuity of its plasma screen terminals with high resolution graphics. It is now supplied as a turnkey CAI system by Control Data Corporation, with a large amount of quality courseware. In the TICCIT project, the most notable feature is the use of color monitors at the terminals, and the development of college level courseware by authoring teams.

All the major projects that were examined used a dedicated time-sharing computer. In the earlier projects this was a large mainframe; for the more recent projects, greater use was made of mini-computers.

At the present time, however, all projects are being effected by the rapid changes in computer technology which are taking place. Although the first computer was only produced in 1946, there have already been several generations of such machines. The first generation used vacuum tubes; these were succeeded by computers using transistors; the present micro-computers use silicon chips. The improvements in reliability, the increase in speed, and the reduction in size and cost have all been dramatic. In particular, this applies to the microcomputers using silicon chips.

The first microprocessor, or central processing unit on a chip, was marketed by INTEL in 1971. To produce a microcomputer, this had to be assembled with memory and other chips, and with devices to perform control functions such as input and ouput; it also required a power supply and, above all, a software operating system. It was not until 1975 that the first microcomputer was marketed by Altair, in kit form for the hobbyist. A further two years were required before the first turnkey microcomputer appeared, of the kind that an educator could use. This was the Commodore PET 2001 microcomputer, introduced tentatively because the company was uncertain whether a market existed. Its success led to the rapid appearance of a range of home computers, including the TRS-80, APPLE and COMPUCOLOR, all supporting the BASIC programming language. Somewhat more powerful and flexible microcomputers were based upon the S-100 bus. In total, probably well over 250,000 microcomputers had been sold by the end of 1979, at prices from $750 upwards. Speed and power are still increasing, whilst physical size and cost are still decreasing. These machines have almost all used a microprocessor which is eight bits long.

The power of a microprocessor is a function of its speed, and its length in terms of bits. An 8-bit processor is therefore much more powerful than the original 4-bit processor produced by INTEL, and can directly address a much larger memory bank. It forms the basis of a microcomputer which may be as powerful as many university computers were 16 years ago. A microcomputer such as the PET or APPLE is therefore capable of delivering quite effective CAI programs to one user. With the addition of a floppy disk it can store a complete library of such programs. Moreover, it will frequently offer color and quite useful graphics.

However, any extensive CAI system must have a central storage device on which to keep student records, so that progress may be monitored and summary reports may be printed out for the use of the teacher. The same storage system could also hold programs, management systems, and data on the programs which would be used to modify and refine them. With such an arrangement, any student can use any of the terminals; the records are accessed and the student automatically routed to the next lesson.

The time-sharing systems used in the past to support CAI on mainframes or mini-computers had centralized record keeping facilities as an integral part of the system. Users shared not only the central processing unit, but also the memory of the computer. With individual microcomputers, the problem is to arrange that all users are attached to a central storage system. To solve the problem at reasonable cost, the procedure is to use another microprocessor to control a central memory bank consisting of several floppy disks or, preferably, one of the new eight inch hard top disks. With appropriate software this gives a "shared resource" or "distributed processing" system capable of supporting a number of users.

Several multi-user systems are already available, based upon the present 8-bit microprocessors. Unfortunately, they generally support no more than seven users, a number which is unlikely to be adequate for most schools for very long.

Already, however, 16-bit microprocessors are in use for single user microcomputers, and indications are that by the end of 1980 they will be provided with the necessary control hardware on chips, and multi-user software systems, capable of supporting at least 16 ports. It is claimed that the most powerful of these systems will support up to 100 terminals, either "dumb" or "intelligent"; and it may safely be assumed that they will be at least as powerful as the present mini-computers. Furthermore, 32-bit microprocessors are already announced and will be produced specifically to support multi-user systems by the end of 1981.

It is therefore considered that, by the end of 1980, several multi-user microcomputer systems will be available, capable of meeting the present CAI needs of the schools. They will involve a comparatively small initial capital outlay and have as low a cost per port as a mini-computer. Since they will be of the size appropriate for a single school or a small school system they will incur minimal communications costs. However, it will be possible to join such microcomputer systems by means of a communications network if so desired. At some point in the future, such communications could possibly be provided by a videotex system.

Another change at present taking place in CAI delivery systems is the move away from text bound courseware. A number of multi-media terminals are now in use, frequently based upon a microprocessor. Videodisc players are becoming available and will provide on one disk, under computer control and in color, up to half an hour of moving images with a choice of two audio channels, or up to 54,000 single frames. Much has to be learned about the mastering of such disks, about their integration in a CAI system, and about writing courseware to use them effectively. For certain applications, however, it is considered that videodiscs may come into use quite rapidly.

The present technological changes relating to the future of CAI indicate that it will become both cheaper and more effective. When an examination is made of the commercially available packaged systems, however, it is concluded that nothing suitable for use in schools is at present marketed. Some systems use a large mainframe and are too expensive; some provide only drill and practice courseware oriented to U.S. curricula and fixed in format; and some use a technology which is acknowledged to be now obsolescent.

The conclusion is that CAI for schools should make use of the new microcomputer and videodisc technology, which will give a per student hour cost of hardware well below that of present instruction. With this type of delivery system, and taking into account the expected positive effect upon student performance, the cost/benefit of CAI will probably be substantial.

Experience with CAI at the present time shows, overall, improvement of student achievement and attitude towards learning has been good. When it has been used to provide all instruction in a subject area, achievement has generally been at least as high as when conventional methods of instruction have been used, frequently in less time. When CAI has been introduced as a supplement to other methods of instruction, achievement levels have frequently increased substantially. Students have expressed positive attitudes to this new means of learning and there is evidence that attention span has increased.

However, it is clear that CAI is not a substitute for the teacher; rather, it is a tool for the teacher. The accumulated evidence indicates the necessity of keeping the teacher at the center of the educational enterprise. Further, teachers who have participated in CAI projects have had very positive attitudes towards the use of computers in instruction.

It must be recognized, however, that very few teachers had opportunity to learn about computers during their initial training, and fewer still learned anything about microcomputers. There is therefore an urgent need for in-service courses in computer applications, and for encouragement of teachers to make use of the graduate programs in computer applications already offered by the universities in the Province. Also, it is recommended that a unit on computer literacy be made compulsory in the initial teacher training courses, whilst further optional units should be available to those students wishing to learn more about computer applications in education.

Such courses should be perceived as an integral part of a program to improve the quality of education in the Province by gradually introducing the use of CAI in the form of demonstration projects.

It is unfortunately the case that virtually no extensive CAI programs, suitable for use in the schools, are at present available on microcomputers. This is even more obviously the case with regard to multi-media CAI programs. Examples of good courseware are available, but in languages or for computers which for other reasons can not be used. This implies that essentially all the necessary courseware will have to be produced.

It is therefore recommended that CAI demonstration projects should be established, each in a school or school district, based upon a multi-user microcomputer system, and with the active co-operation and involvement of teachers who will use the courseware. Preferably, such projects should arise from the initiative, interest and competence of the teachers. It will be necessary, however, to have assistance from persons already experienced in the development and use of CAI, and to have co-ordination of projects at the Provincial level in order to avoid duplication of effort. Copyright of all CAI programs developed in this manner should be retained in the public domain, and attempts should be made to facilitate portability.

In the case of each project, provision should be made for continuity over a period of at least five years, with the expectation that it would become institutionalized at the end of that time.

An important consideration would be the provision of release time for teachers engaged in courseware development, and adequate professional recognition of the expertise which they would develop in the area of computer applications.

In selecting projects, priority should be given to those students and those subject areas most likely to benefit from the introduction of CAI. These are students for whom the patience and repetitiveness of the computer are of great assistance in their learning, those who require individual attention, those who for some reason have failed to learn in the normal classroom environment, those who feel inadequate and inferior and do not seek help from a teacher for fear of displaying their ignorance, those who do not have ready access to schools, and those studying subjects in which the computation and information processing power of the computer enhance learning.

Such students include those who are physically and mentally handicapped; those who are disadvantaged, either economically or because they live in remote areas with rapid teacher turnover; and those who live in rural areas where educational provision is less adequate than it is in the cities. Students in adult education courses would derive special benefits from CAI, as also would students studying topics where simulations are appropriate, and students studying foreign languages.

For all such persons it is necessary to provide a high instructor/student ratio because of the variety of student problems and needs. This results in a high cost per student hour of instruction, yet the amount of individual attention and continuity provided for each student is still inadequate. It is in such situations that CAI is both comparatively inexpensive and likely to effect the greatest change in least time.

The subject areas particularly needed by such students are introductory mathematics, reading, and language, oriented to slow or adult learners where appropriate; all branches of science; vocational education; and foreign languages.

Specific CAI demonstration projects which are proposed, therefore, are for:

1. Basic living skills and vocational skills for the handicapped
2. Remedial mathematics, reading and language at elementary level
3. Remedial mathematics, reading and language for adults
4. High school vocational courses such as electronics and automotives
5. High school science
6. High school mathematics
7. Junior high school mathematics
8. A high school foreign language

As several of these topics cover very wide areas of the curriculum, they could be broken down into a number of sections each concentrating on a more specific area. Some demonstration projects should be in rural areas.

In determining priorities, the importance of teacher interest should be borne in mind. Projects should be accorded preference which arise from the initiative of teachers able and willing to develop the necessary courseware.

These recommendations for specific demonstration projects are considered to be the focal point of this report. They address both the major problems, namely lack of courseware and teacher apprehension regarding CAI, while at the same time providing some CAI as soon as possible for those who would benefit from it most.